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Claims

[c1] 1. A semiconductor resistor device structure comprising a single trench buried in a semiconductor substrate, the trench filled with a conductive material, and lined with an insulator material.

[c2] 2. The semiconductor resistor device structure of Claim 1, further comprising:
a plurality of trenches buried in a semiconductor substrate, each trench filled with a conductive material to form a trench resistor element and lined with an insulator material, each trench having a contact portion formed at a bottom of said trench;
a connection band of doped semiconductor material conductively connecting bottom contact portions of two adjacent trenches in first alternating configuration;
a top surface connection of conductive material conductively connecting top surfaces of adjacent trenches in second alternating configuration;
wherein said buried trench resistor structure comprises a chain of conductively connected trench resistor elements exhibiting a precise resistor value.

[c3] 3. The semiconductor resistor device structure of Claim

2, wherein said chain of conductively connected trench resistor elements form a semiconductor trench resistor array exhibiting a precise resistor value.

[c4] 4. The semiconductor resistor device structure of Claim 2, wherein said conductive material filling said trench comprises one selected from the group comprising: TaN and polysilicon.

[c5] 5. The semiconductor resistor device structure of Claim 2, wherein said trench resistor element includes a collar of dielectric material formed above said bottom contact portion.

[c6] 6. The semiconductor resistor device structure of Claim 5, wherein said dielectric material includes material selected from a group comprising: oxides, nitrides, and oxynitrides.

[c7] 7. A semiconductor resistor device structure comprising a single trench buried in a semiconductor substrate, the trench including a dielectric material lining, and including a conductive material layer formed within the trench having a bottom and two side portions extending along the length of the trench, the trench filled with a dielectric material.

[c8] 8. The semiconductor resistor device structure as

claimed in Claim 7, further comprising:
a plurality of trenches buried in a semiconductor substrate, each trench including a dielectric material lining, and including a conductive material layer formed within the trench having a bottom and two side portions extending along the length of the trench, and said conductive material layer including top layer portions extending to connect a top layer portion of a respective adjacent trench resistor element to form a chain of conductively connected trench resistor elements exhibiting a precise resistor value.

[c9] 9. The semiconductor resistor device structure of Claim 8, wherein said chain of conductively connected trench resistor elements forms a semiconductor trench resistor array.

[c10] 10. The semiconductor resistor device structure of Claim 8, wherein said conductive material layer comprises one selected from the group comprising: TaN and polysilicon.

[c11] 11. The semiconductor resistor device structure of Claim 8, wherein each said trench resistor element includes a collar of dielectric material surrounding said conductive film and a dielectric material filler.

[c12] 12. The semiconductor resistor device structure of Claim 11, wherein said dielectric material includes material selected from the group comprising: oxides, nitrides, and oxynitrides.

[c13] 13. A programmable semiconductor resistor structure comprising:
at least two semiconductor resistor device structures connected through the intermediary of a fuse device, each semiconductor resistor device structure comprising:
a plurality of trenches buried in a semiconductor substrate, each trench filled with a conductive material to form a trench resistor element and lined with an insulator material, each trench having a contact portion formed at a bottom of said trench;
a connection band of doped semiconductor material conductively connecting bottom contact portions of two adjacent trenches in first alternating configuration;
a top surface connection of conductive material conductively connecting top surfaces of adjacent trenches in second alternating configuration, said buried trench resistor structure comprising a chain of conductively connected trench resistor elements exhibiting a precise resistor value,
wherein a total resistance value of said semiconductor resistor structure is programmable by blowing said fuse

device.

[c14] 14. The programmable semiconductor resistor structure of Claim 13, wherein said at least two semiconductor resistor device structures are connected in series through a connecting fuse device.

[c15] 15. The programmable semiconductor resistor structure of Claim 13, wherein said at least two semiconductor resistor device structures are connected in parallel.

[c16] 16. A programmable semiconductor resistor structure comprising at least two semiconductor resistor device structures connected through the intermediary of a fuse device, each semiconductor resistor device structure comprising a plurality of trenches buried in a semiconductor substrate, each trench including a dielectric material lining, and including a conductive material layer formed within the trench having a bottom and two side portions extending along the length of the trench, and said conductive material layer including top layer portions extending to connect a top layer portion of a respective adjacent trench resistor element to form a chain of conductively connected trench resistor elements exhibiting a precise resistor value, wherein a total resistance value of said semiconductor resistor structure is programmable by blowing said fuse device.

[c17] 17. The programmable semiconductor resistor structure of Claim 16, wherein said at least two semiconductor resistor device structures are connected in series through a connecting fuse device.

[c18] 18. The programmable semiconductor resistor structure of Claim 16, wherein said at least two semiconductor resistor device structures are connected in parallel.

[c19] 19. A method for forming semiconductor resistor device comprising the steps of:

a) forming a plurality of trenches in a semiconductor substrate, each trench separated with a dielectric region;

c) forming a buried contact portion at a bottom of each trench;

d) forming a collar of dielectric material above said buried contact portion in each trench;

e) filling each trench with a conductive material to form a trench resistor element having said buried contact portion;

f) forming a top surface connection of conductive material that conductively connects top surfaces of adjacent trench resistor elements in a first alternating configuration;

g) ion implanting a connection band of doped semiconductor material conductively connecting bottom contact

portions of two adjacent resistor elements in a second alternating configuration, whereby a chain of conductively connected trench resistor elements is formed that exhibits a precise resistor value.

[c20] 20. The method of forming a semiconductor resistor device as claimed in Claim 19, wherein at least two formed semiconductor resistor devices are connected in series or in parallel configuration through the intermediary of one or more fuse devices, said method including the step of blowing a fuse device to achieve a desired total resistance value.

[c21] 21. A method of forming a semiconductor resistor device comprising the steps of:

a) forming a plurality of trenches in a semiconductor substrate;

b) forming a collar of dielectric material throughout the length of each said trench;

c) depositing a conductive film having top, side and bottom film portions surrounded by said collar in each said trench to form a trench resistor element, said top portions of each said conductive film extending to connect a top portion of a respective adjacent trench resistor element to conductively connect each trench resistor element as a chain of conductively connected trench resistor elements exhibiting a precise resistor value; and,

d) filling a remaining portion of each trench with a dielectric material.

[c22] 22. The method of forming a semiconductor resistor device as claimed in Claim 21, wherein step c) of depositing a conductive film having top, sidewall and bottom film portions comprises the step of selectively etching thin conductive film material inside the trench to remove the front and back conductive film material portions, leaving the sidewall and bottom film portions.

[c23] 23. The method of forming a semiconductor resistor device as claimed in Claim 22, wherein said step of selectively etching thin conductive film material inside the trench includes applying a wing mask when selectively etching said buried conductive film material portions, said etching leaving a gap inside said trench, said method further comprising: filling said gap with a dielectric material.

[c24] 24. The method of forming a semiconductor resistor device as claimed in Claim 21, wherein at least two formed semiconductor resistor devices are connected in series configuration or in parallel configuration through the intermediary of one or more fuse devices, said method including the step of blowing a fuse device to achieve a desired total resistance value.